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CANADIAN WATER POWER

AND ITS

ELECTRICAL PRODUCT

IN RELATION TO THE

UNDEVELOPED RESOURCES OF THE DOMINION.

BY

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PRESIDENT.

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PRESIDENTIAL ADDRESS

Canada with a small population and insufficient capital has nevertheless held a foremost position in the products of the Forest and the Fisheries, as well as in the quality of those cereals and fruits which attain their highest development in a northern latitude. In live stock she has not suffered by comparison with any other portion of this continent, while in dairy products she is pre-eminent. If she has not, until recently, made much progress in mineral development, it has been more from want of money than of mines. If she has been long in attaining a position as a manufacturing country, it is accounted for by the fiscal and financial conditions of a sparsely settled country, the smallness of a home market, and the competition of greater capital and out-put, and therefore cheaper production elsewhere.

Amongst the many partially developed resources of Canada, perhaps there is none more widespread or more far reaching in future results than her unsurpassed Water Power. The value of this has been enormously enhanced, first by the expansion of the Wood Pulp manufacture, and the introduction of electro-chemical and metallurgical industries for which this country possesses the raw material; and, more recently, by the revolution which has been brought about by success in transmitting the energy of water falls from remote and inconvenient positions to those where the work is to be done.

Electrical transmission brings the power to the work, and when the prime mover is water, we have the cheapest power, and perhaps nearest approach to perpetual motion which it is possible to obtain;—one which is always "on tap," and, like gravity, maintained without cost and applied without delay.

An examination of any good map of our broad Dominion reveals, as its most striking feature, an extraordinary wealth and remarkably uninterrupted succession of lakes and rivers, suggestive of ample rainfall, the first great requisite in the occupation of any country. This feature would be still more impressive if all the waters could be shown on the map. Over large areas only the more important rivers have been explored and delineated; while in the surveyed districts many are necessarily omitted to leave room for other information to be given.

These rivers and lakes have been the most important factors in the settlement of the country, as they formed the earliest lines of approach for the penetration and exploration of the interior, and for the exploitation of our forests. The lumberman followed the trapper and the fur trader, the axe supplanted the rifle, and thus the country was opened up by men who knew not only where to begin, but, by their calling, were best equipped as pioneers.

The frontier, where not already occupied by the French, was necessarily rapidly settled in the first place by the Loyalists of 1776, who could not stand upon the order of their departure after their homes were confiscated. These found the rivers their earliest friends from whence they obtained the means of shelter and of employment in the only industry by which money could then be obtained, viz., the floating of timber and potash to Montreal and Quebec.

Over a length of several thousand miles between Labrador and Alaska and over a width of several hundred miles, there is an almost continuous distribution of lakes, lakelets and rivers;—the lakes of varied outlines, dimensions and elevations above sea level, and many possessing facilities for the storage of their flood waters. This power of storage has been largely taken advantage of by lumbermen to retain the needed supply for their Spring "drive" into the main stream. In many places the outlet from the lake, or the connection between a chain of lakes, is a narrow cleft in rock where an inexpensive dam will hold back the water supplied by the winter's accumulation of snow.

With the exception of her prairie region, the rivers of Canada differ from the Mississipi, Missouri and Ohio, and the larger part of their tributaries, in that they are not naturally navigable from their mouths, or above tidal influence to any considerable extent, except in detached sections: while the former are navigable for thousands of miles and are therefore without water power. Those great western rivers flow upon a nearly uniform grade of a few inches per mile, whilst the St. Lawrence and its tributaries are interrupted by Rapids, Chutes and Cataracts, affording a great variety, quantity and quality of Water Power.

In the United States, between the Atlantic coast and the Rocky Mountains, as far south as the Gulf of Mexico, and as far north as the Dakotas, (with the exception of part of New York and New England) there is an entire absence of lakes; while throughout Canada, north of the St. Lawrence and stretching northwest toward the Mackenzie River Basin, these are innumerable, in fact have never been numbered, and thousands of the smaller ones have never been represented on any map.

The upper sections or sources of most of the Canadian Rivers are chains of lakes, occupying in many instances the greater portion of the water course. These head waters are often upon nearly the same eleva-

tion and interlocked with the sources of other rivers flowing in opposite or different directions, and separated by narrows necks of land at a low divide, rendering diversion from one to another possible, a feature which has in some places been utilized by lumbermen,—fearless of any legal injunction.

This terrace-like profile of the rivers and their frequent expansion into lakes, often dotted with islands, not only enhances the beauty of the scenery, but, for utilitarian purposes, constitutes a series of elevated natural mill ponds, containing latent power of unknown extent and value, awaiting that demand upon them which is now being made in consequence of the discovery that our second rate forest growth which has hitherto served chiefly to ornament their shores and islands, has become the most important, and can be ground into pulp and rolled into paper to meet the ever increasing demands of the newspaper, the bookmaker, and the innumerable forms into which wood pulp can be compressed for useful or ornamental purposes,—or as a substitute for wood or metal.

These steps from high to lower levels in every rivulet, branch, tributary or main stream of nearly every one of our northern rivers produce more or less broken water which never freezes over but remains open during the coldest weather, giving an alternation of closed and open water sections, of ice covered lakes and of broken water in rapids, which may cover miles in extent, as well as at chutes or cataracts with more or less open water above and below them.

It is an interesting question for specialists to determine what effect, if any, this often large percentage and almost general distribution of open water during the coldest weather (of which every stream large or small has a portion) may have in modifying the extremes of temperature in these northern latitudes. When all the ground is frozen solid and covered with a deep mantle of snow, extending over the lakes and checking increasing thickness of their ice covering, large bodies of water are impounded and maintained at a temperature above the freezing point, although there may be fifty degrees of frost in the air, and are constantly poured forth into this frigid atmosphere.

It is conceded that our Great Lakes modify the temperature of their border lands, and although these open water spaces in our northern rivers may be inferior in surface, they exist on every river having rapids or falls, and extend over such a vast field that their aggregate area must be very large. Unlike the Great Lakes these open spaces are constantly receiving fresh supplies of warmer water to temper the severity of the air. Such "breathing holes" (as they are sometimes called) are necessarily comparatively shallow, and are the only places, after all other water is frozen over, where "anchored" ice is formed and found. This

differs from lake ice in that the latter melts where it freezes, while anchor ice, when compelled by milder weather to let go its hold upon the bottom, rises, and is immediately drawn under the fixed ice below, and does not dissolve until the river breaks up in the Spring. The latent heat of water, dis-engaged in freezing,—which process occurs so frequently during the five months of winter,—is imparted to the atmosphere, but is not again absorbed by melting ice, as would be the case in lakes, or in deep sluggish rivers.

Again, radiation is supposed to play an important part in "anchoring" the floating particles of ice to the river bottom, which is said to be cooled so rapidly by the ice laden current above it as to become frozen, and then begin to attract the passing ice needles, and fix them to its bed.

If mother earth, in mid-winter, contributes any of her impounded heat to the outer atmosphere, these almost innumerable unfrozen spaces certainly offer great facilities for giving vent to her suppressed emotions.

WATER POWER.

From the Straits of Belle Isle to Montreal, and thence ascending the Ottawa, the tributaries of the St. Lawrence and of the Ottawa descend, through the Laurentian region, from elevations of 1800 to 1000 feet above tide, and debouche within a few miles of each other except immediately about the Saguenay. In many cases they bring their principal cataracts very near their outfall, notably in the case of the famous Falls of Montmorency, which, leaping directly into the St. Lawrence from a height of 250 feet, are utilized to light the streets and drive the tram cars of Quebec.

Somewhat similar conditions exist on the south shore of the St. Lawrence until the Richelieu river (the outlet of Lake Champlain) is reached, where at Chambly, water power is about to be used to send the electric current into Montreal, in competition with steam, and with a similar water power from the Lachine Rapids.

The divide between the St. Lawrence and the Ottawa is studded with lakes west of the Rideau Canal, a principal outlet for which,—on the south,—is the River Trent discharging into the Bay of Quinte, with large mills and much undeveloped water power at its mouth: and on the north, some half a dozen important tributaries discharging into the Ottawa.

At Sault St. Marie, a water power canal fed from Lake Superior supplies the largest pulp mill yet erected in Ontario, and a similar work at the Lake of the Woods (which lake is 1000 feet above tide) gives power to the largest flour mill in the Dominion. The waters of the Winnipeg

river (the outlet of the Lake of the Woods) descend about 300 feet, unused, into Winnipeg Lake, adjoining Lake Manitoba, from whence the water system extends to the Saskatchewan, and thence via Athabasca, the Great Slave and the Great Bear Lakes, to the Arctic circle.

No reference has been made to the long established water power in the older districts, on the Saguenay, or those between Montreal and Quebec, and upon the Ottawa, nor to the more recent and extensive pulp and paper establishments;—it being the object of this paper to draw attention to the continuity and broad distribution of water power across the Continent, on Canadian territory, and to the unnumbered natural resevoirs of water at elevations which impart to them latent powers for the future development of this country.

British Columbia has not been included in this field, because its occupied portion is separated by our great prairie region from the lake system of Eastern Canada, which system is deflected toward the North West at the Lake of the Woods. This province is by no means deficient in water power, although it has been little used as yet where mines are on high levels, and because steam could be more readily applied. On the other hand, it is the only Province in which Hydraulic Mining is in operation; and where gold is found in quantity sufficient to warrant the great outlay of capital necessary in connection with that system.

In the Kootenay, water wheels, with or without electrical transmission, are necessary for water power, in order to mine, pump, and crush the gold bearing rocks; but in the Cariboo district, water power is applied in the simplest form, without wheels or wires, by direct pressure from a nozzle, as is done in Ottawa from a fire hydrant.

While the mountains south of the Canadian Pacific Railway are rich in metallic veins, the region north of this Railway extending into the Arctic Circle, appears to be a veritable land of Havilah, a continuous "Placer" gold field, in which much of the precious metal is to be obtained by Hydraulic mining, wherever that is practicable.

This gold field, over a thousand miles in extent between the Fraser and Yukon Rivers, and of unascertained width, has been exploited at Cariboo, (from whence fifty million dollars has been taken), at Cassiar and Omenica, and recently at Atlin, all in British Columbia;—as well as in the far famed Klondike, in the Yukon district, said to be the richest gold field in the world.

Water, in whatever way it is used, is necessary to the recovery of this gold, but in many places water power alone will profitably unearth it from its hidden recesses. This is collected in quantity from lakes, and resevoirs on the high levels, and carried for miles by ditches, aqueducts and flumes, to the banks of a primeval, deserted river channel, at the bottom of which, under forest covered clay banks, lies the auriferous

gravel studded with boulders and resting on the bed rock. Under a head of about 300 feet "six inch rapid fire" hydraulic guns are pointed against the bank, breaking down the earth, uprooting trees, scattering boulders and washing out the gold—which remains in the traps set for it in the bottom of the sluices after all else has been carried off by the power of the water.

These "machine guns", called "giants" and "monitors", are models of simplicity as well as of ingenuity and efficiency. While working they are great consumers of water,—and can only be used when the ground is unfrozen, but this season is generally sufficient to use up all the water which can be collected at the necessary elevation.

It requires at least two men to hold and direct the force of the issuing stream from an Ottawa fire hydrant, but a boy can direct the movement of a stream, twenty times greater in quantity and fifty percent stronger in pressure, as it rushes forth from the nozzle of one of these "giants",—which is fixed to a loaded platform, and moved forward as the bank in front of it melts away.

A thin short tube, of larger diameter, projects beyond the nozzle to which it is fixed by trunnions, so that the tube can be moved independently, both horizontally and vertically, to touch the issuing stream, which immediately recoils from the obstruction, moving the "giant's" nozzle in the opposite direction. Thus a boy "behind the gun" can control its movement and compel the "giant" to fall back upon his own resources for motive power.

HORSE POWER.

It is impossible to give anything but an approximate estimate either of quantity or value of the available water power over so vast an area, because the first would involve the survey of every power site; and, as to the second, the value begins when the power is wanted.

All which now can be done is to state the conditions and endeavour to estimate the quantity, hypothetically. What is needed for an estimate is the quantity of water and the amount of fall which can be relied upon at the site for each power. To get the first, a measurement of the minimum flow at each point would be necessary in low water years, and for the second, some local knowledge as to river levels, back water, etc.

In the absence of such surveys we must fall back upon the average rainfall of the whole region as far as that can be procured for any time, and assume the proportion of this precipitation (of rain and snow) which, after deductions for evaporation, the demands of vegetation, or infiltration, would reach the wheels. An allowance must also be made for that portion of the rainfall which may be carried off in floods.

The area over which this precipitation would be in reach for water power purposes, would embrace all the main land of Canada south of the St. Lawrence, as well as all north of it in the St. Lawrence valley, and so much of the Hudson Bay watershed as can be utilized, or imported by transmission.

As regards the power of the water thus estimated, we must embark in a much more speculative estimate as to the average fall which should be assigned to it for the whole region. We have in the undeveloped districts some scattered meteorological observations to assist us in estimating probable rainfall, and we have also a few barometrical observations giving the height above sea level of summit waters. On lower levels we have more numerous rain gauges, and summit levels ascertained by railway surveys.

For the whole river the total fall may be less than 100 feet, as in the case of the French river which has Lake Nipissing for a mill pond, or rise to 1500 feet or more as at the rivers below Anticosti. In the case of the French river (which is the lower part of a longer stream) we have surveys, and know that its whole fall can be utilized, as would be done if it is made navigable by locks and dams. In the others (where no surveys have been made) some will be more or less like French river, while at others only a portion of the total fall upon them may be profitably utilized. The most valuable will be those which, like Montmorency, bring all their water with sufficient head to the point where it is worth most. The upper sections of the rivers will be the least valuable, as having less water and being more remote until reached by a new railway, or a transmission wire.

We can therefore only state a hypothetical case especially as to the power to be assigned to the available water. Where the rainfall is known, the proportions which reach the streams have been ascertained, in the construction of resevoirs for water supply and other purposes. The chief difficulty with respect to the quantity of water is the want of rain gauges over so great an extent of unoccupied territory.

Assuming therefore an average annual precipitation of twenty-four inches and taking one-half of this as available for water power, every ten square miles would yield an average of nearly one horse power for every foot of fall. A million square miles (and there is much more) would give nearly 100,000 Horse Power for every foot of fall: As there would be several hundred feet of fall which could be utilized our water power must be immense,—and commensurate with this country in other respects.

The above applies only to the tributaries of the St. Lawrence and the Ottawa, and to the Hudson Bay watershed so far as that may be utilized. The Canadian portion of the water power of the St. Lawrence, from

Lake Superior to Montreal, in which there is a fall of 546 feet, is not included, being below the level of the tributaries.

We have measurements of the flow in both the St. Lawrence and the Ottawa in cubic feet per second, as follows:

	c. ft. per sec.
In St. Mary's river, outlet of Lake Superior..........	80,000
In St. Clair river, outlet of Lake Huron..............	225,000
In Niagara river, above the falls....................	265,000
In St. Lawrence river above the rapids..............	300,000
In Ottawa river, above Lake of Two Mountains........	35,000

Canada's share of the St. Lawrence water power from Lake Superior to Montreal would be about ten million horse power.

Canada has half the water of the St. Lawrence from Lake Superior to Cornwall, and all of it between Lake St. Francis and Montreal; but only a portion of this half could be utilized,—and this would apply more or less to the Ottawa and other rivers, where all the power could not be utilized without an expenditure probably beyond its value.

The power at Niagara has been estimated at seven million horse power, from less than half of the fall between Lakes Erie and Ontario, but the flow of the Niagara River, as given above, does not support so high an estimate. The whole of this fall (over 320 feet) can be utilized on the Welland Canal, but the quantity is comparatively insignificant, from the limited channel and necessarily low velocity of the current in it.

In like manner the whole fall upon our canals in the St. Lawrence can be utilized subject to the limitations imposed by the requirements of navigation. Because these canals have not had the work for which they were intended, they have in some cases become mill races rather than slack water channels. This has been the less felt, hitherto, on account of the lightness of their west bound traffic, the strong current toward the mills being in favor of the deeper laden east bound craft, thus incidentally compensating for a violation of canal maxims.

While water power was at first the only substitute for the windmill in new countries, and its economy as well as superiority has always been recognized, several causes have contributed to limit its more general application. Before the invention of the turbine in the first half of the present century heads exceeding about seventy feet could not be utilized on account of the comparative weakness and excessive cost of wheels of large diameter. In these days of structural steel, and "Ferris" wheels, this difficulty could be overcome; but, with the turbine, the conditions are reversed, the higher the head the less the size and cost of wheels, so that the most valuable water powers were the most cheaply utilized in this respect.

A previous check to the greater extension of water power was given in the latter part of the last century by James Watt's discovery of the stream engine, which by bringing the power to the work, to the city, and to the mine, revolutionized industrial conditions.

A still greater revolution has recently occurred which brings water power to the front again, by its amalgamation with electricity, whereby its economical power is transferred to the work, over many miles of distance, upon a single wire.

Within the last ten years high voltage electricity has been firmly established with annually increasing power of extension, and this has brought Canada into the first rank of economical power producing countries. Water is thus represented by a power to which it can give birth, but which is superior to its own, in that, where ever transplanted, it can do nearly all the parent power could do, as well as give light, heat and greater speed: moreover it has given rise to industries only possible with abundant cheap electricity. What is more important to us is that such industries are those for which Canada possesses the raw material, but which, without water power, she could not engage in.

There are important industries in which we have for some time utilized water power, for which electricity is not indispensible; but which equally require large amounts of cheap power, and are capable of indefinite extension: but while these may not need the intense electric current necessary for electro-chemical industries, they will find electrical transmission of inestimable value in many situations; while, for lighting and heating purposes, water power is invaluable to all.

Heretofore we have cut our spruce into deals and exported it to Europe, and more recently into pulp wood and exported that to the U. S.; but, manufactured by our water power into paper, the raw material would yield this country ten times the value it is now exported for.

The extension of railways combined with electrical transmission, will promote the local manufacture of such wood products (including all valuable hard wood) as can bear transportation; thus giving the largest amount of local employment, as well as tonnage to the railway; and delivering us from the position of "hewers of wood" for other countries.

ELECTRICITY.

In order to present more fully the recently enhanced value of our Canadian water power, some reference is necessary to certain properties of electricity, the power which has happily been described as "the most romantic form of energy" by Wm. Henry Preece, C. B. F. R. S., in his recent address as President of the Institution of Civil Engineers.

Inasmuch as the cost of production of electrical energy depends upon continuity of output, water power must be the ideal one for this purpose, at least until some cheaper power is discovered. In some places where steam is now used for electric light other industries have been added to secure the more continuous use of the power in daylight hours.

The only quality in which any deficiency has been exhibited by electricity is for lighthouse purposes, a lesser power of penetration in fogs, in which respect it is inferior to oil or gas: but even this, has in the present year, been more than compensated for by the successful application of "wireless telegraphy", by which, in any weather, communication between the ship and the shore can be established. The shores of the St. Lawrence from the Atlantic to the Lakes are lined with water power which can be used to light, in fair, or protect, in foul weather, the passing vessel; to ring the bell or blow the horn.

When water is applied for light and power purposes its economy is always the important factor; but it is chiefly to its value for electro-chemical industries that Canada will look to reap the greatest benefits, because, in these it is not merely a question of competition of power producers, but one in which intense electricity has the monopoly, and in the case of some of them, as in the production of aluminium, calcium carbide, carborundum, etc., their existence depends upon ample supplies of an intense electric current, for the generation of which abundant and cheap water power is indispensible.

Touching electro metallurgical processes Mr. Preece says:

"Every electrolyte requires a certain voltage to overcome the affinity between its atoms, and then the mass decomposed, per minute or per hour, depends solely upon the current passing. The process is a cheap one and has become general. Three electrical H. P., continuously applied, deposits 10 lbs. of pure copper every hour, from copper sulphates, at the cost of one penny. All the copper used for telegraphy is thus obtained. Zinc in a very pure form is extracted, electrolytically, from chloride of zinc produced from zinc blende, in large quantities. Caustic soda and chlerine are produced by similar means from common salt. The passage of electricity through certain gases is accompanied by their dissociation, and by the generation of intense heat. Hence the arc furnace. Aluminium is thus obtained from cryolite and bauxite. Phosphate is also separated from apatite and other mineral phosphates. Calcium carbide, obtained in the same way, is becoming an important industry."

"Electrical energy can be generated on a coal field where coal, of good calorific value, is raised at a cost of three shillings per ton, cheaper than by a water fall, even at Niagara."

Eastern and Western Canadian coal fields are separated by thousands of miles, but water power is abundant throughout nearly all this coalless region.

Our western coal fields are vast and their market at present limited. If coal can be raised cheaply enough and the raw material for the work be discovered in the neighborhood, they may give rise to electro-chemical and electro metallurgical industries without the intervention of water power.

The commercial production of calcic carbide (acetylene gas), by electrolysis, is the discovery of Mr. T. L. Wilson, (a grandson of the late Hon. J. M. Wilson of Saltfleet, Ontario,) who has established works on the water powers of the Welland Canal and has shipped this product all round the world.

The electric production, commercially, of caustic soda and chlorine is under the patent of Mr. Ernest A. Lesueur, son of the Secretary of the General Post Office Department, Ottawa. This manufacture is now being carried on by a Boston Company at a New England water power.

MINING.

There is another field nearly as widespread as our water power in which electricity is destined to play a most important role, and this is Mining, which is now spreading over the Dominion with the same rapidity as the utilization of our forests for pulp and paper purposes. Over this area minerals have been discovered and in many cases tested and successfully worked, and from recent results we appear to be on the threshold of remarkable developments in this direction, especially as so small a portion of so great an area has been prospected sufficiently for mining purposes.

For power purposes alone, electricity is invaluable in mines, and its multifarious uses (as enumerated by Mr. Preece) are "for moving trams and for working hoists: it lights up and ventilates the galleries, and, by pumping, keeps them free from water. It operates the drills, picks, stamps, crushers, compressors, and all kinds of machinery. The modern type of induction motor, having neither brushes nor sliding contacts, is free from sparks and free from dust. Electric energy is safe, clean, convenient, cheap, and produces neither refuse nor side products."

The Canadian mining districts are well supplied with water power, and all the wonderful effects of electricity are available for us upon a larger and more economical scale than elsewhere.

In connection with this abundance of water power, and from the fact that a large proportion is at present situated remote from present railways and present settlements, the question of profitable limit of elec-

trical transmission is most important,—if indeed it be now possilbe to put a limit on anything connected with electricity, with or without the aid of a wire. If, as reported, Lord Kelvin has placed the profitable limit at 300 miles, this is sufficient to utilize the greater part of the water power upon the two watersheds north of the St. Lawrence River.

Professor Elihu Thomson says "Up to the present time it was practicable to transmit high pressure currents a distance of 83 miles using a pressure of 50,000 volts. If a voltage higher than that were used the electricity would escape from the wires into the air in the form of small luminous blue flames."

As showing how far we are yet behind nature, Prof. Thomson says the estimated voltage from a lightening discharge ranges from twenty to fifty million volts.

Wherever the raw material for electro-chemical, electro-metallurgical, or other industries, affords sufficient inducement, and the water power is at hand, the forest will be penetrated much more rapidly than heretofore, and settlements advanced in new directions.

What can be done in this direction is best illustrated by the development of a single industry in the wilds of Minnesota north of Lake Superior, and adjoining Canadian territory. Over four hundred miles of standard gauge railways have been built, through what was a trackless wilderness in 1885, to reach iron ore beds, the ore from which is shipped to Lake Erie and thence again railroaded 200 miles into Pennsylvania. This one business has, in mines, railways, docks and fleets of steamers, required an investment of $250,000,000, and has led to as low a rate, by water, as 1 cent per bushel for wheat between Chicago and Buffalo, and 20 cents per ton for coal from Lake Erie to Duluth, nearly 1000 miles. One-half of the charcoal iron, and more than half of the pig iron made in the U. S., is smelted from Lake Superior ore.

ELECTRIC RAILWAYS.

The substitution of electricity for steam as the motive power for railways on many roads is regarded as inevitable sooner or later. It has already taken place as regards suburban railways, notably in the case of the Charlevoix road and Hull and Alymer railway, where water is doing the work which has heretofore been done by coal. The chief obstacles to an early change on the larger roads are the hundreds of millions invested in locomotives, and the very large outlay required to equip existing steam roads with the electric system. The principal inducement would be the passenger service, owing to the increased speed possible,—it being confidently stated that, with electricity, a speed considerably over one hundred miles per hour could be attained. Moreover there

would be entire abolition of the poisonous smoke which drops upon the Pullman in preference to any coach ahead of it.

While the conversion of trunk lines would be attended with a cost which is for the present prohibitory, this objection does not apply to new lines which may be worked independently, or in connection with electric ones. When the time arrives for such railways, water power will have a field of usefulness of which we can at present form little conception. Water wheels and wires would displace the coal docks, the coal laden vessels, the huge coal yards, and the trains required for distributing their contents over hundreds of miles of lines.

An interior line connecting Lake St. John, on the Saguenay, with Lake Temiscamingue, on the Ottawa, which could ultimately be extended, viâ Missanabi, Nepigon, and Lac Seul to the Saskatchewan, would be a colonization road, removed from the frontier ;—one which could be worked possibly altogether by water power, and would open a virgin tract in which electro-chemical and electro-metallurgical industries might arise, as well as those connected with the products of the forests and the mine.

TRANSPORTATION.

The more extended use of our Water Power, in the immediate future, for manufacturing and mining purposes, especially for the electro-chemical and metallurgical productions, naturally leads to the consideration of the character of the output, especially with regard to markets, and transportation problems generally.

Transportation, next to production, is the most important commercial question to a country of vast distances and low priced products, affording great tonnage, such as we produce; and for which we have expended hundreds of millions in Canals and Railways, Harbours, Light-Houses and Steamers, a sum disproportioned to our realized wealth, as it certainly is to our population. But, "*noblesse oblige*"; we possess a vast estate, are compelled to develop it—and await results.

The question of transportation determines, to a great extent, the existence, or otherwise, of a possible industry, and enhances or diminishes the value of every article of export just in proportion to its efficiency and economy. On the other hand, where transportation is necessarily expensive, cheap production may maintain an industry;—and here is where our abundant water power may come in.

The geographical position of Canada in relation to the commercial centre of gravity of the North American continent is at least noteworthy. This centre is very near Lake Erie. From the western end of this lake the water route to the Atlantic, at the Straits of Belle Isle, follows the general direction of a great circle which cuts the commercial heart of

Europe, and is therefore upon the shortest route, or "air line". Our two peninsulas, Sarnia-Detroit and Sault Ste. Marie, which are the railway gates of the Lake region, afford the most direct routes to the Atlantic for all the North Western States, and are traversed by the trunk lines of railway. From Lake Erie water communication on the largest scale extends through Lake Huron to the extremities of Lakes Michigan and Superior. One third of the population of the United States are dependent upon the Great Lakes, largely as to exports and imports, and wholly as to rates,—which are fixed by the water for the rail routes.

One-half of the population of the United States is found within a radius of 400 miles from Cleveland, a Lake Erie port claimed to be second only to the Clyde as a ship building one, and also the largest iron ore market in the world.

The paper and pulp industry as well as some of the electro-chemical and metallurgical ones (to the present list of which many additions may be made) are distinguished by the large tonnage produced, the output of several Pulp mills exceeding one hundred tons per day. For this the St. Lawrence is the natural route for exportation, and to it this heavy tonnage is of the greatest importance as a means of attracting "tramps" as well as liners during the open season.

Increase of sea tonnage into the St. Lawrence is essential to our inland commerce: by it only can sufficient west bound freights be secured to attract a proper share of the commerce of the Lakes, after all has been done to give to the latter quick despatch at Montreal or Quebec.

There is probably no place in the world where inland transportation is carried on with greater expedition and economy than in the valley of the St. Lawrence. This is due to the character of the inland navigation, unequalled elsewhere, and to the influence which this exerts upon the Railways competing with it: and also, because the valley of the St. Lawrence is not only the greatest highway for agricultural products, but of mineral ones, as well as of the products of the Forest and the Fisheries.

More than half of the iron ore produced in the United States is mined around Lake Superior. Into this Lake an increasing number of railways are pouring the produce of the vast wheat fields between it and the Rocky Mountains, and thus placing this grain within a thousand miles of Montreal, which is the nearest seaport, by hundreds of miles, and the only one which can be reached by vessels capable of navigating the lakes.

Wheat grown in the foot hills of the Canadian Rockies has already reached Lake Superior by an all rail haul of fifteen hundred miles, a distance considered prohibitory in the early days of railways, as one which would absorb the whole value in the cost of carriage.

The lateness of harvest in our Northwest, and the early closing of navigation in the St. Lawrence, will soon over-tax all our means of transport, both water and rail, during the interval between September and December. The Welland and St. Lawrence canals and the portage railways between Montreal and Lake Huron constitute the Canadian routes, and much, which cannot arrive by water in time for export, will be stored up at nearest lake ports for winter railway carriage to tide water warehouses on the St. Lawrence, for export at Atlantic ports,—or for conversion into flour at Ontario and Quebec water powers.

This accumulating tonnage from our western plains and our eastern forests must call for a proportionate extension of export facilities which should attract tonnage to the St. Lawrence. Already Montreal has eighteen regular lines of steamers to transatlantic ports, exclusive of tramps. New York alone of the Atlantic ports exceeds this in number. Montreal has five regular lines to Liverpool and the same number to London, two lines to Glasgow and two to Hamburg, and one each to Bristol, Manchester, Belfast and Antwerp. Baltimore has twelve regular lines of steamships to Europe, Boston nine, and Philadelphia eight. No doubt all these Atlantic lines exceed Montreal in number and tonnage of vessels as well as in cargo carried. They have twelve months navigation against seven for the St. Lawrence. The real significance of Montreal's eighteen regular lines of steamships is the demonstration, that, in spite of climatic drawbacks, or inferiority in other respects, the St. Lawrence is the route towards which northern exports will gravitate during its open season.